

Soil amendment application, after road construction alters resource availability and can benefit native over non-native species

Lindsay Ringer

Graduate Degree Program in Ecology, Colorado State University

Cynthia S. Brown

Bioagricultural Sciences and Pest Management, Graduate Degree Program in Ecology, Colorado State University

Vic Claassen

University of California, Department of Land, Air, and Water Resources

Meagan Schipanski

Department of Soil and Crop Sciences, GDPE, Colorado State University

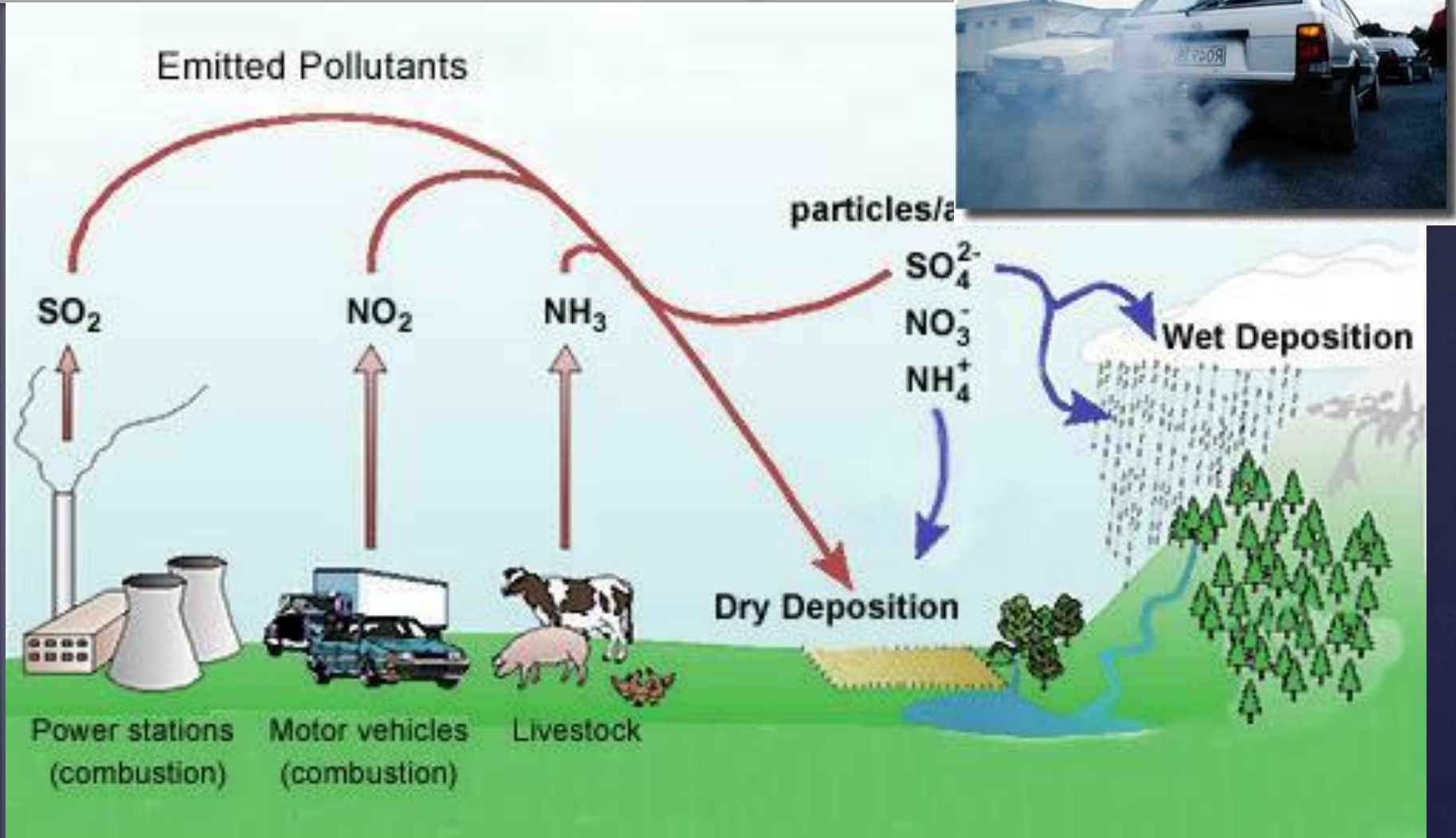


soil resource availability

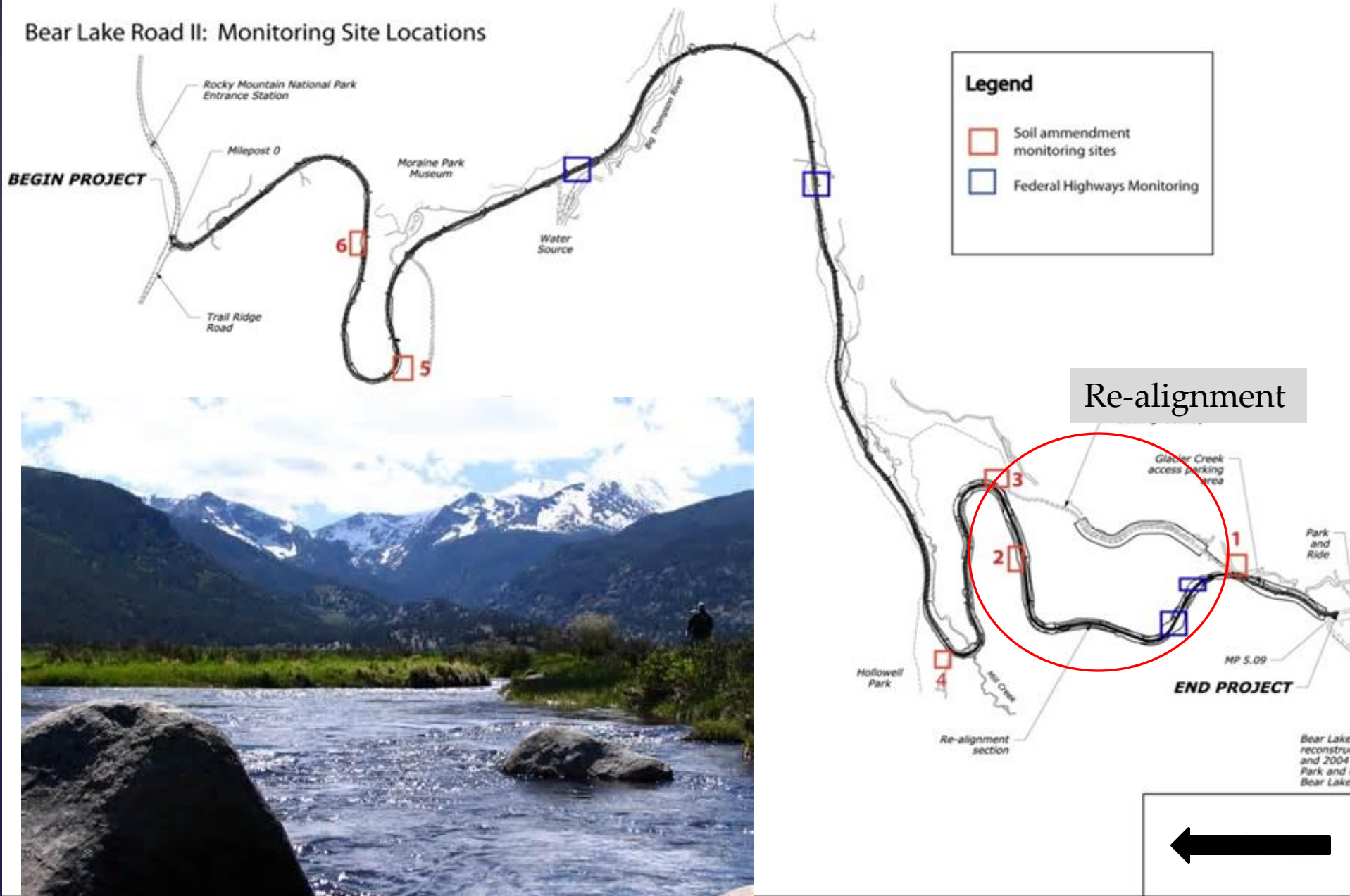


changes due to disturbance

Sources of Nitrogen



Bear Lake Road II: Monitoring Site Locations



Can seeded native species be favored over non-natives with soil amendments that:

↑ Organic matter

↑ nitrogen

↑ water

↓ nitrogen

↓ nitrogen

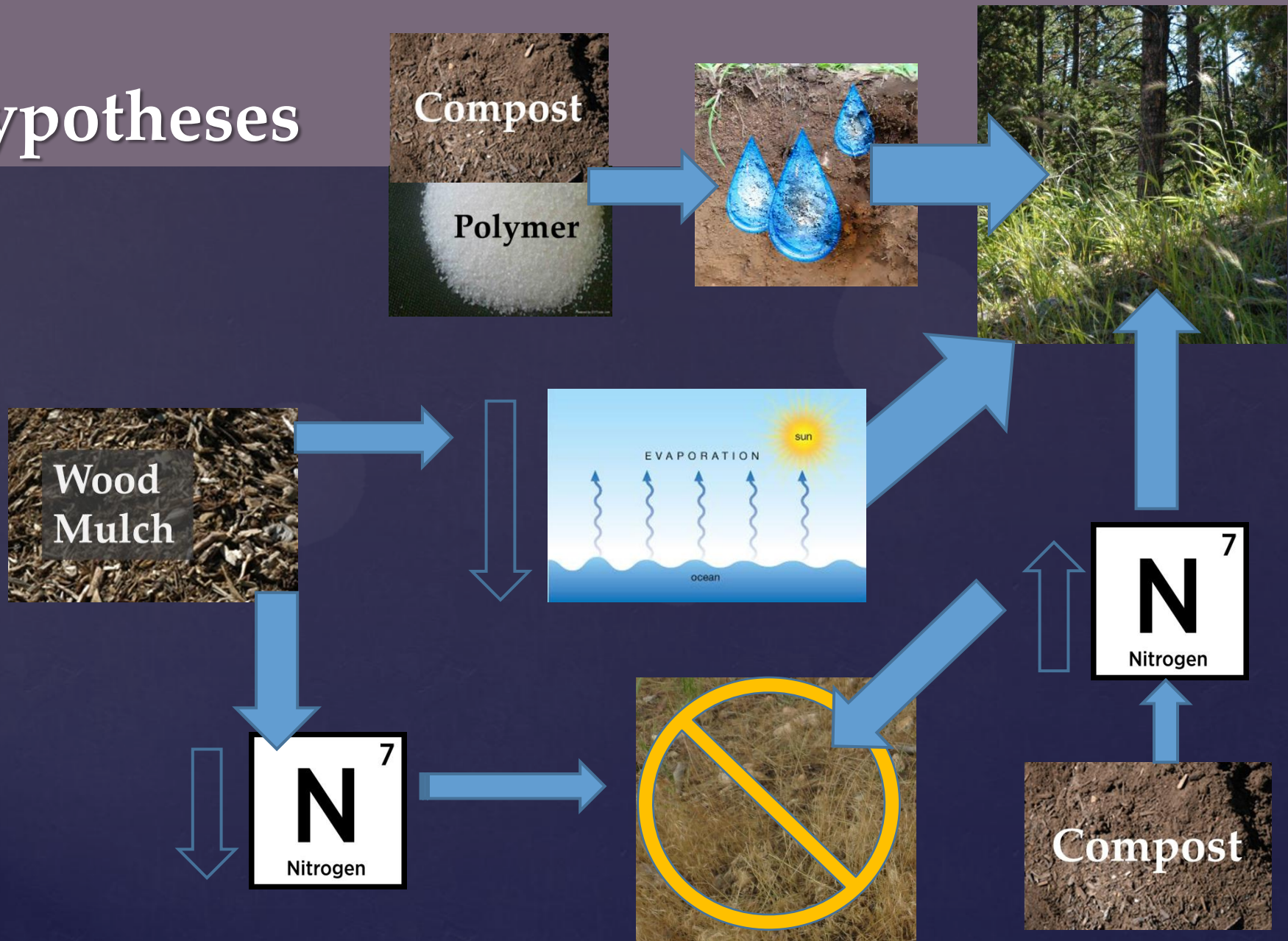
↑ water

Compost

Polymer

**Wood
Mulch**

Hypotheses



Acknowledgements



Brownies: Magda Garbowski, Chris Davis, Amanda West, Peder Engelstad

Lab Assistants: Jeanine Nesky, Nicholas Monzingo

Collaborators: Erin Durant, Rachel Rubin, Chris Davis, Jim Cheatham, Jim Bromberg, Robin Gregory, Christine Taliga (Denver Service Center), Hanem Aboulezz, Paul McLaughlin

Volunteers: Katherine Lease, Graham Tuttle, Eric Knutson, Magda Garbowski, Erika Foster, Robert Condon, Ava Hoffman, Clif McGee, Liana Vitousek



Polymer/Compost Application

Hydro-seeding



Seeded species

All **perennial**, forbs and grasses collected in RMNP and reproduced by the Upper Colorado Environmental Plant Center (Meeker, CO)

Species	Common Name	Percentage	Habit
<i>Antennaria</i> spp.	Pussytoes	1.0	Perennial forb
<i>Artemisia frigida</i>	Fringed sagebrush	6.0	Perennial subshrub
<i>Bouteloua gracilis</i>	Blue grama	6.25	C4 grass
<i>Elymus canadensis</i>	Canada wildrye	22.5	C3 grass
<i>Elymus elymoides</i>	Bottlebrush squirreltail	22.5	C3 grass
<i>Koeleria macrantha</i>	Junegrass	14.0	C3 grass
<i>Muhlenbergia montana</i>	Mountain muhly	14.6	C4 grass
<i>Heterotheca villosa</i>	Harry golden aster	1.5	Perennial forb
<i>Oxytropis lambertii</i>	Purple locoweed	10.8	Perennial forb
<i>Thermopsis divaricarpa</i>	Foothill golden banner	0.08	Perennial forb



Mulch Application

Methods – Response Variables

Soil Moisture

- Mid-growing season (7/26)
- Late-growing season (9/9)

Plant Available N

- Mid-growing season (6/23-7/23)
- Late-growing season (8/13-9/19)

Rainfall, Soil Temperature



Methods – Response Variables

Plant Density (7/28-8/5)

- Native, seeded
- Native, not seeded
- Non-Native

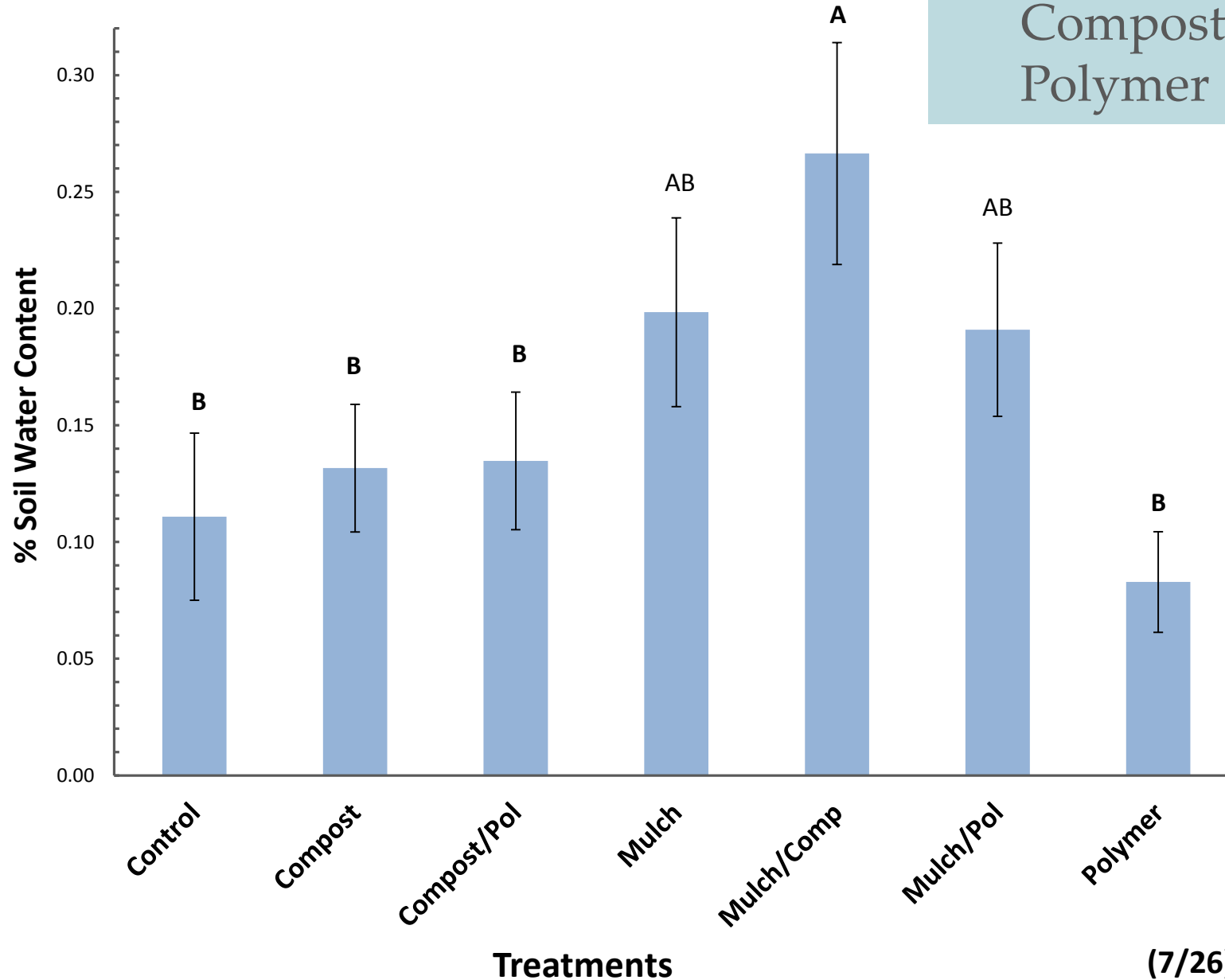


Plant Cover (7/28-8/5)

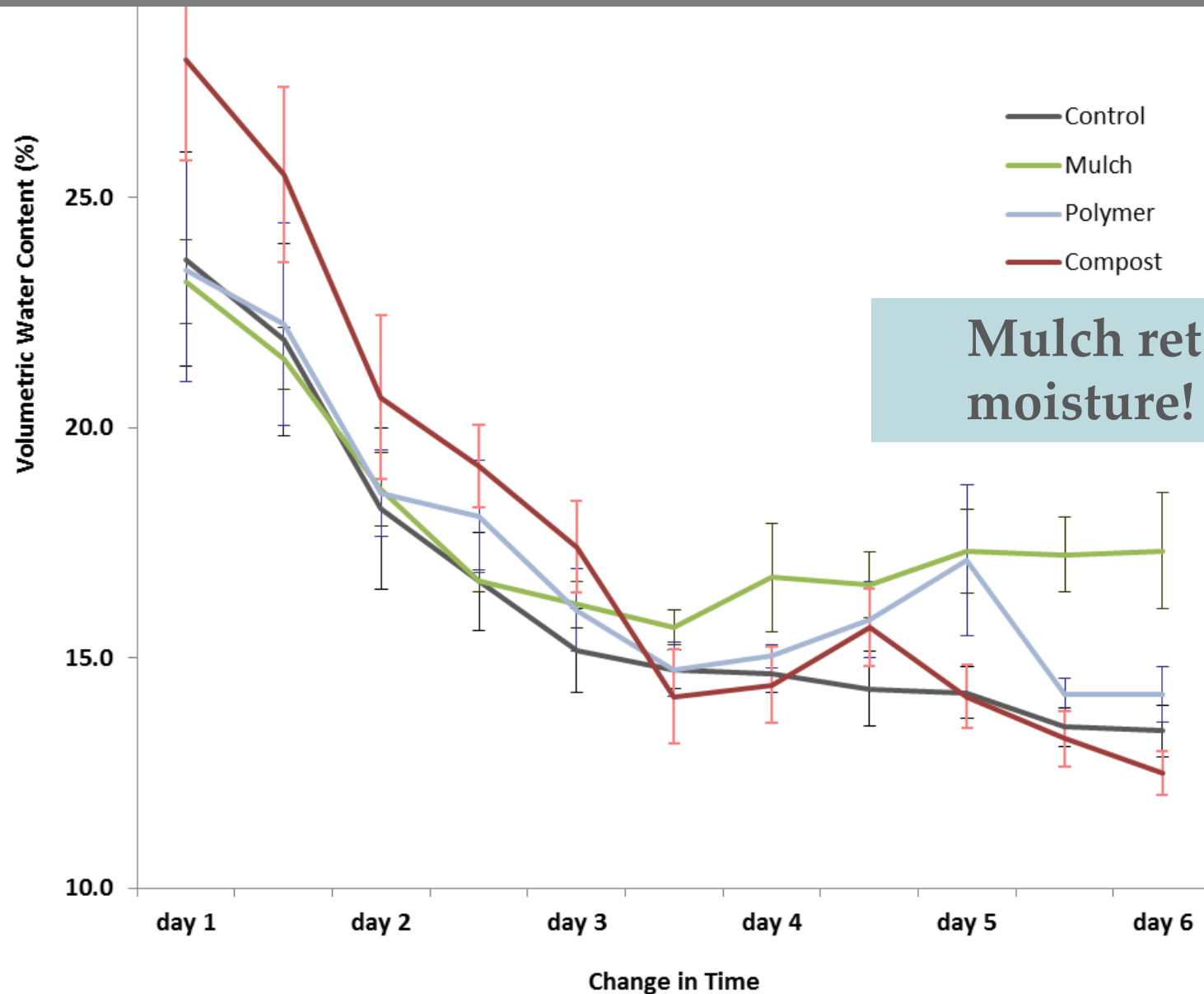
- Native
- Non-Native

Soil Water Content

Mulch + Compost >
Control, Compost,
Compost + Polymer,
Polymer



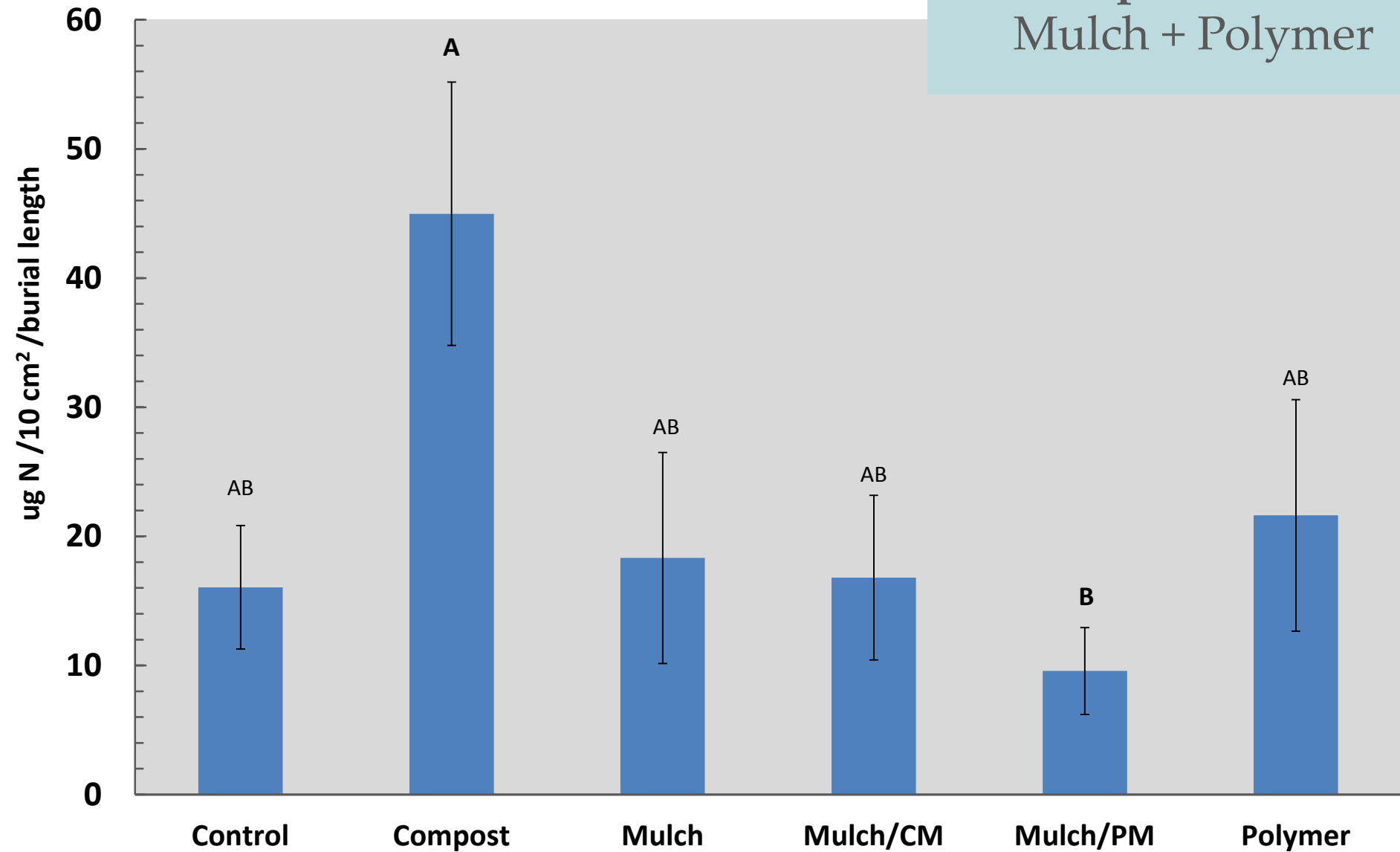
How do these amendments alter loss of soil moisture over time?



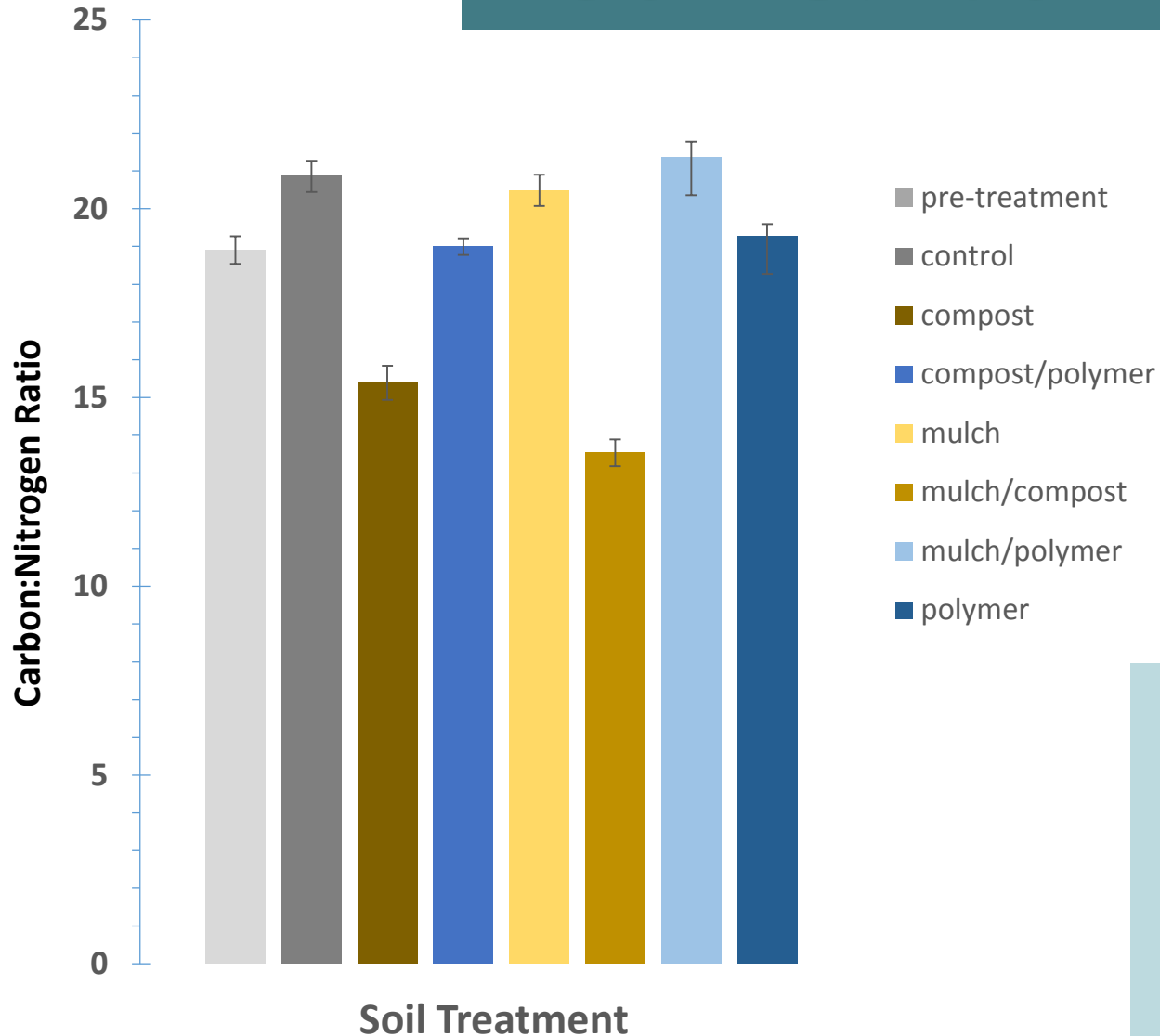
Mulch retains soil moisture!

Plant-Available Nitrogen

**Compost >
Mulch + Polymer**



Soil Carbon: Nitrogen



**Mulch+ Compost,
Compost:**

**increase soil N,
decrease C:N**

Seeded Native Species



Control

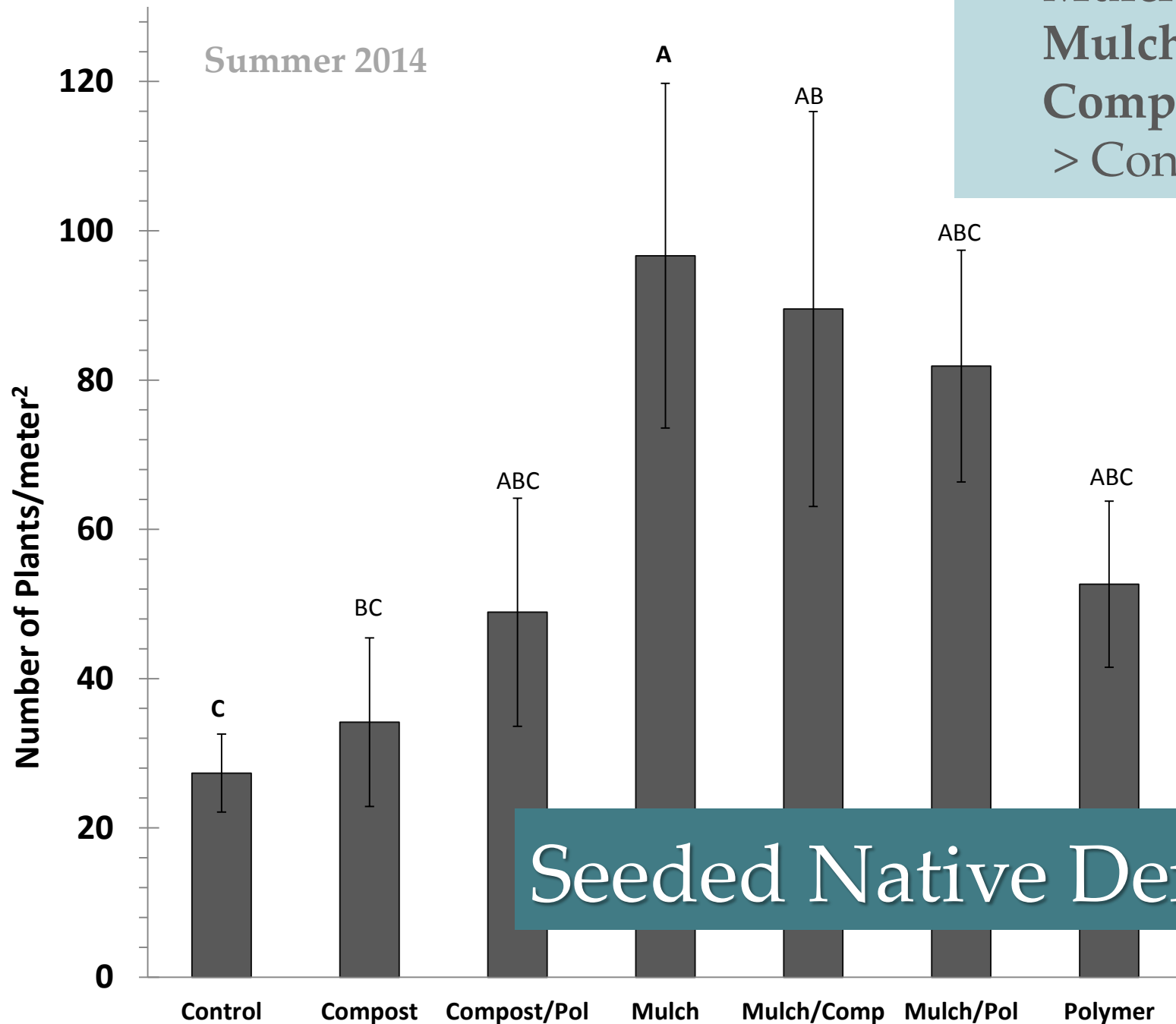


Mulch/Compost



Mulch

Mulch,
Mulch +
Compost
> Control



Seeded Native Density

Unseeded Native Species

Mulch +
Polymer



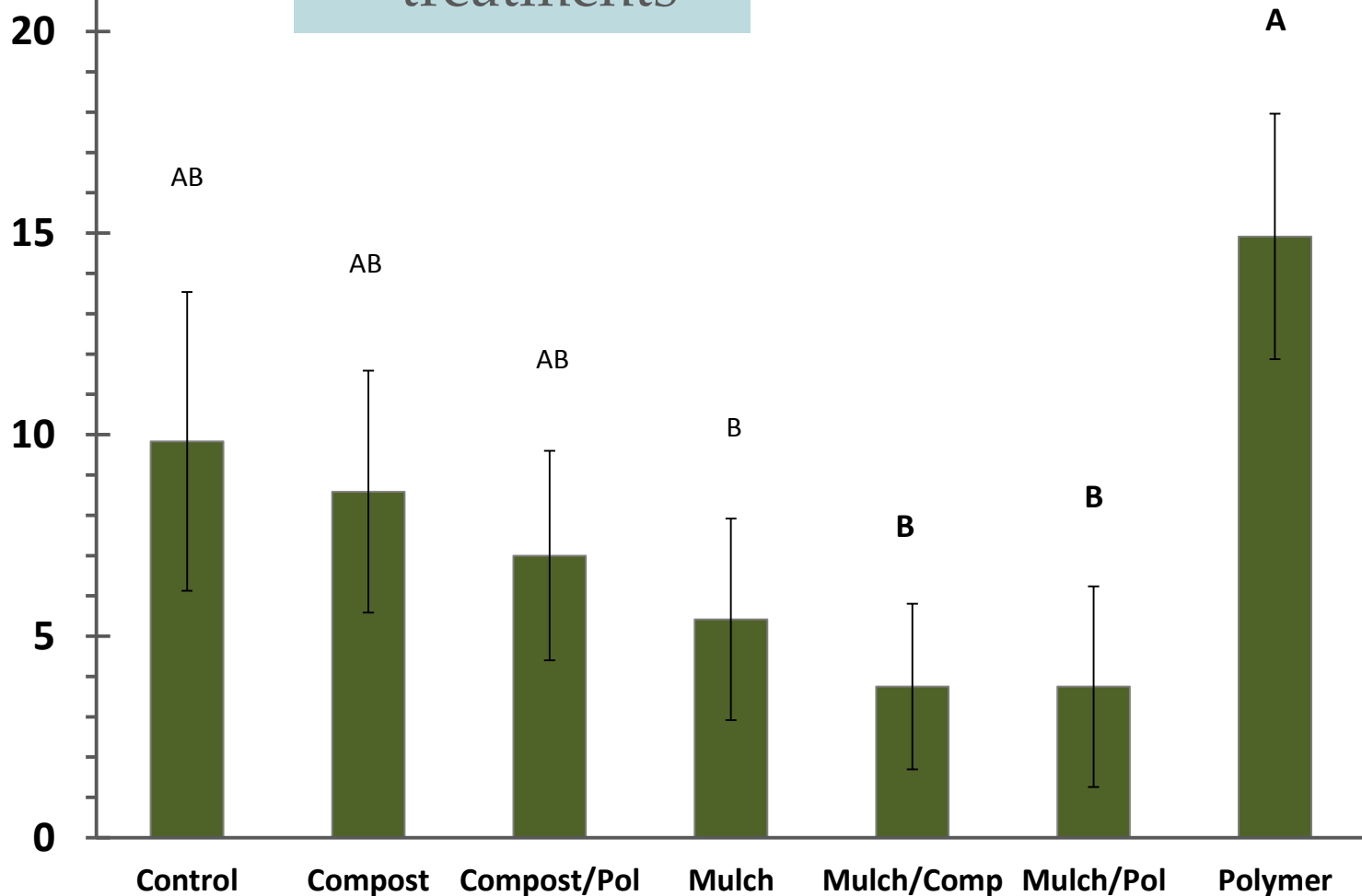
Polymer



Unseeded Native Density

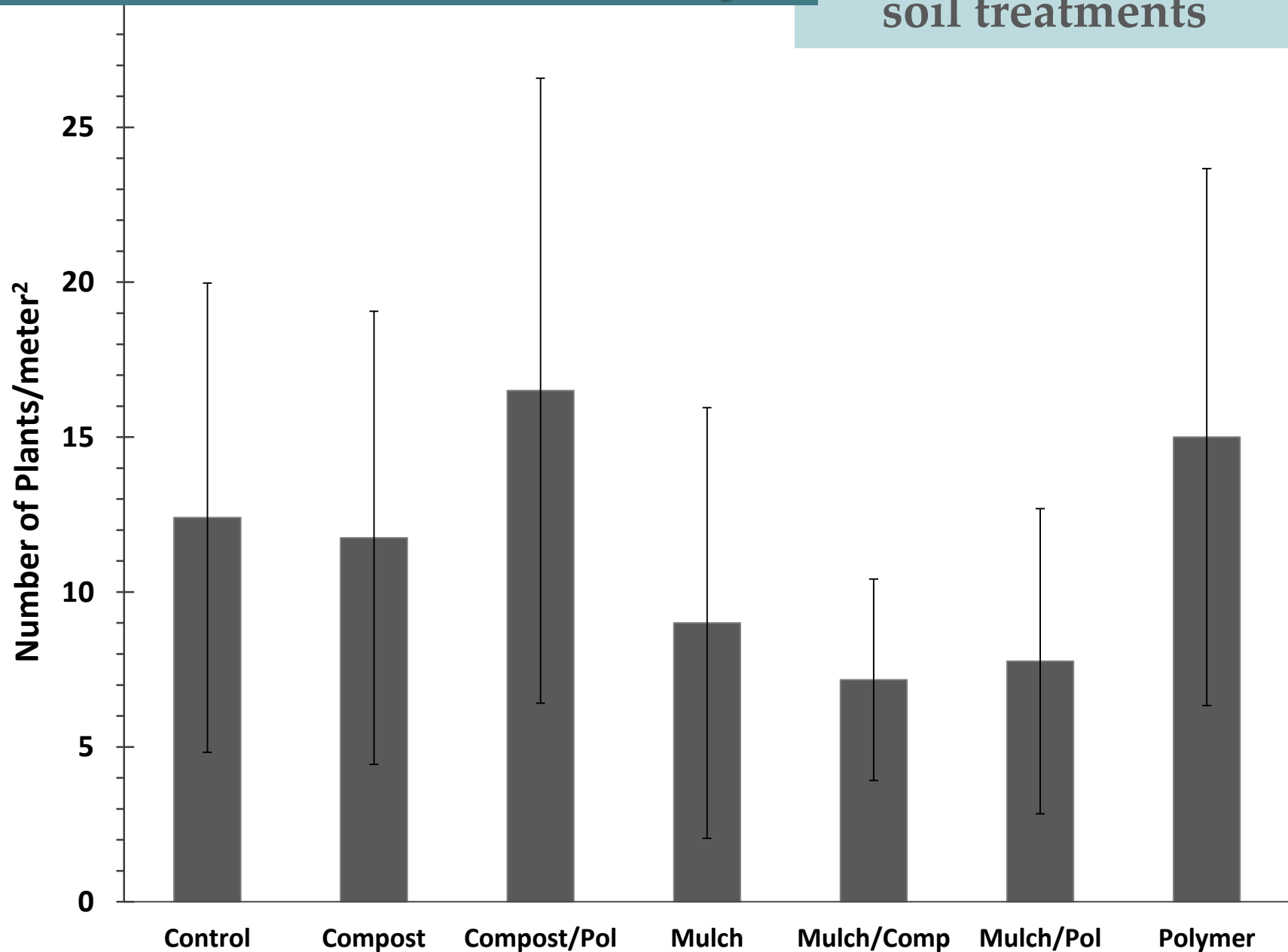
Polymer >
all mulch
treatments

Number of Plants/meter²

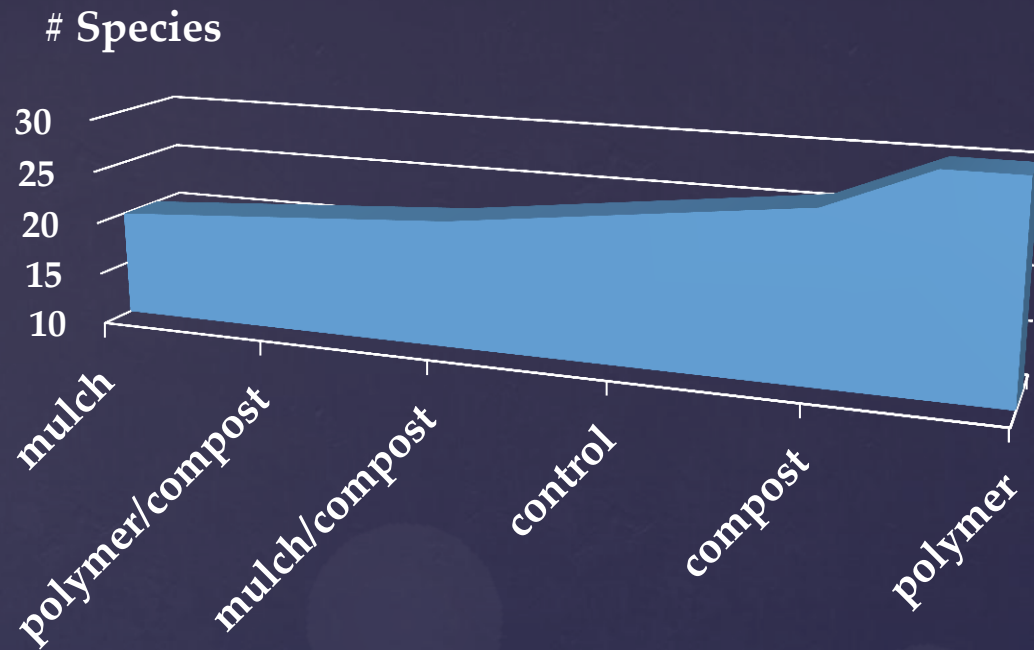


Non-Native Density

No difference among
soil treatments



Plant Diversity by Soil Treatment

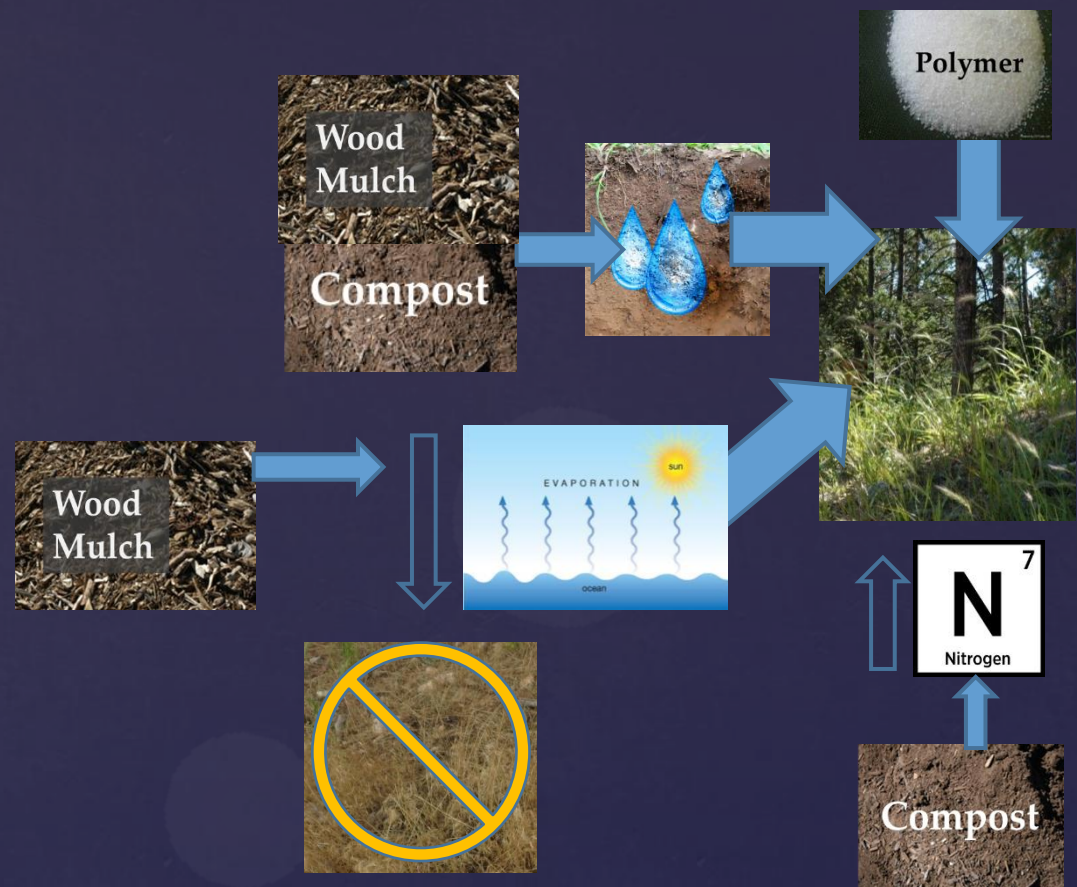


Treatment	Simpson's DI (per m ²)
mulch	0.948
polymer/compost	0.914
mulch/compost	0.942
control	0.941
compost	0.922
polymer	0.943



Plant Species Diversity

Preliminary Findings



- 1) **Soil moisture** greatest in mulch + compost
- 2) **Soil nitrogen** in compost > mulch + polymer
- 3) **Seeded native density** in mulch, mulch + compost > control
- 4) **Unseeded native density** in polymer > mulch
- 5) No difference in **non-native density** between treatments

Soil amendments do change water and nitrogen availability and as a result can increase establishment of desirable species on roadsides.

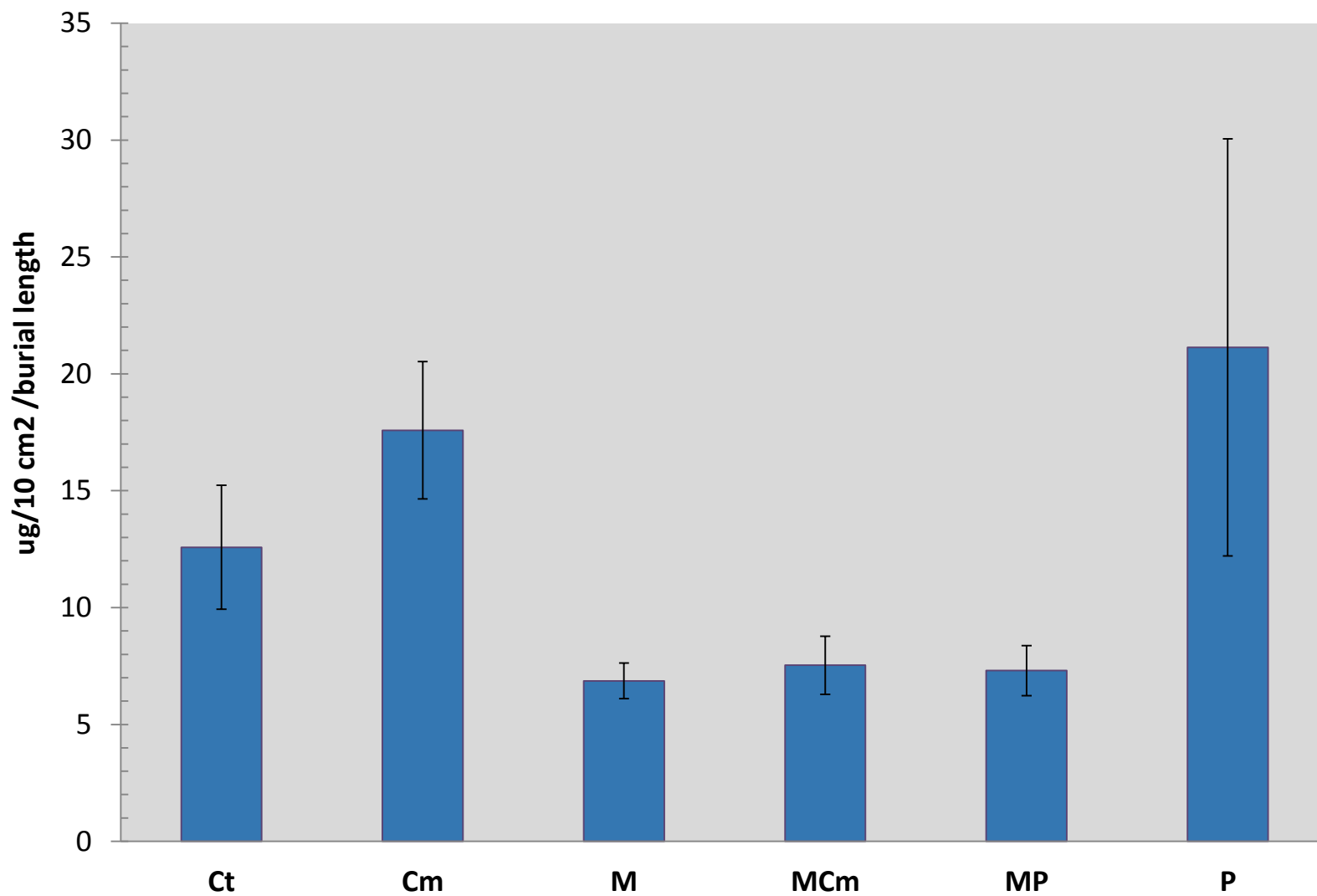


Preliminary Conclusions

- Bochet, E., P. Garcia-Fayos, B. Alborch, and J. Tormo. 2007. "Soil water availability effects on seed germination account for species segregation in semiarid roadslopes." *Plant and Soil* no. 295 (1-2):179-191. doi: 10.1007/s11104-007-9274-9.
- Bromberg, J., S. Kumar, C. Brown, and T. Stohlgren. 2011. "Distributional Changes and Range Predictions of Downy Brome in Rocky Mountain National Park". *Invasive Plant Science and Management* no. 4(2):173-182.
- Campbell, B.D. And J.P. Grime. 1989. "A Comparative Study of Plant Responsiveness to the Duration of Episodes of Mineral Enrichment" *New Phytologist* 112(2):261-267.
- Claassen, V. 2012. "Topsoil Management Plan: Bear Lake Road Phase II" Rocky Mountain National Park, Resource Stewardship. Unpublished.
- Curtis, M. J., and V. P. Claassen. 2005. "Compost incorporation increases plant available water in a drastically disturbed serpentine soil." *Soil Science* no. 170 (12):939-953. doi: 10.1097/01.ss.0000187352.16740.8e.
- Curtis, M. J., and V. P. Claassen. 2009. "Regenerating Topsoil Functionality in Four Drastically Disturbed Soil Types by Compost Incorporation." *Restoration Ecology* no. 17 (1):24-32. doi: 10.1111/j.1526-100X.2007.00329.x.
- Curtis, M. J., M. E. Grismer, and V. P. Claassen. 2007. "Effect of compost incorporation on infiltration capacity and erosion from a decomposed granite road cut." *Journal of Soil and Water Conservation* no. 62 (5):338-344.
- Eldrige, J.D., E.F. Redente and M. Paschke. 2012. "The Use of Seedbed Modifications and Wood Chips to Accelerate Restoration of Well Pad Sites in Western Colorado, USA" *Restoration Ecology* 20.4:524-531.
- Esser, Scott and Lonnie Pilkington. 2011 "Vegetation Restoration Plan: Bear Lake Road Phase II Reconstruction Project Rocky Mountain National Park." doi:2.1.11
- Hooper, D. U. and P.M. Vitousek. 1998. "Effects of Plant Composition and Diversity on Nutrient Cycling" *Ecological Monographs* 68(1):121-149.
- Vasquez, E., R. Sheley, and T. Svejcar. 2008. "Creating Invasion Resistant Soils via Nitrogen Management." *Invasive Plant Science and Management* no. 1 (3):304-314. doi: 10.1614/ipsm-07-059.1.
- Wildlands, Inc. 2013. "Bear Lake Road Phase 2 Hydro-seeding: Rocky Mountain National Park, Colorado." 1.17.2013.
- Yost, Bob. 2013. "Compost Technical Data Sheet: ECOGROW, A1 Organics" 7.4.2013.

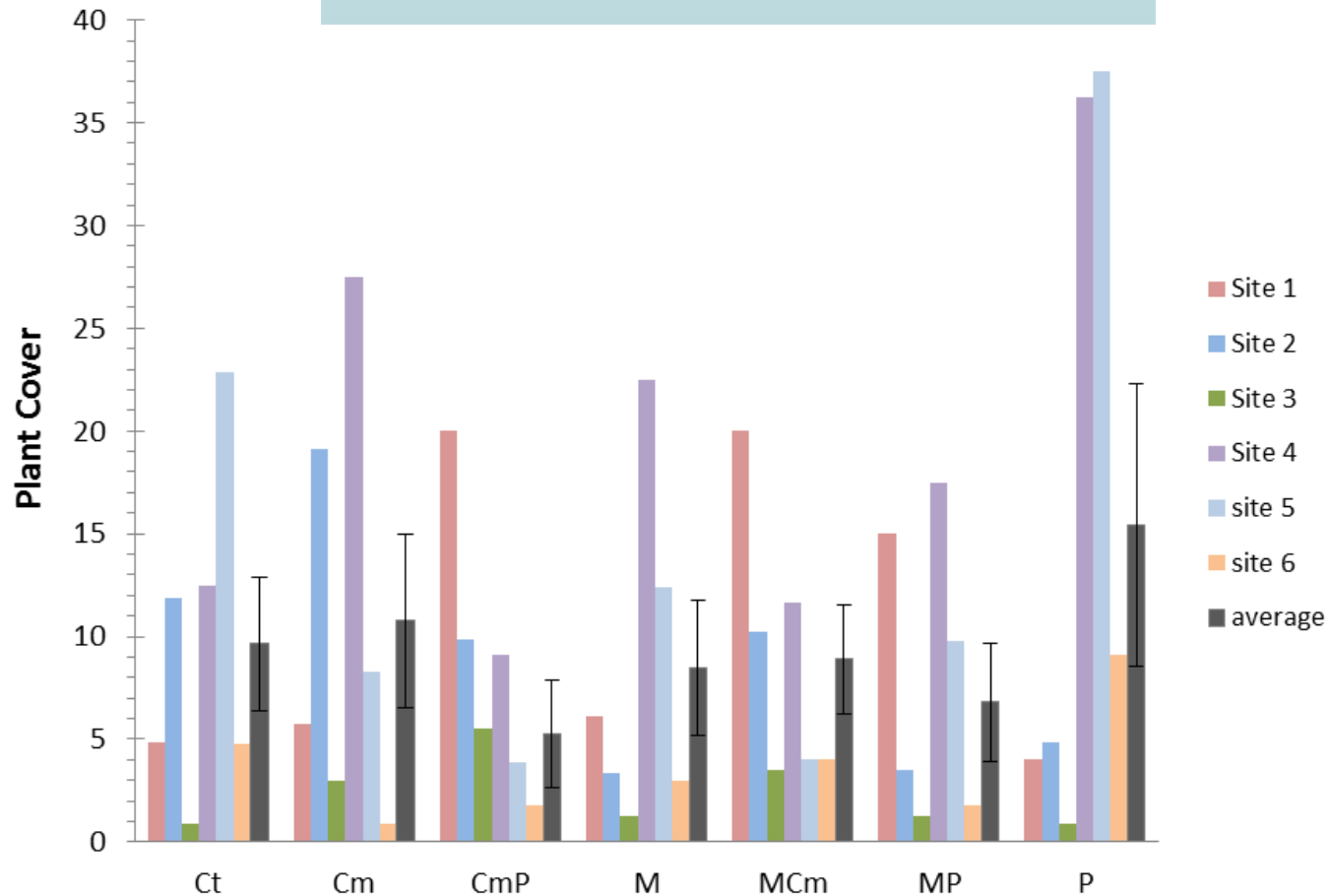
Literature Cited.

Plant Available N (mid Aug-Sept)

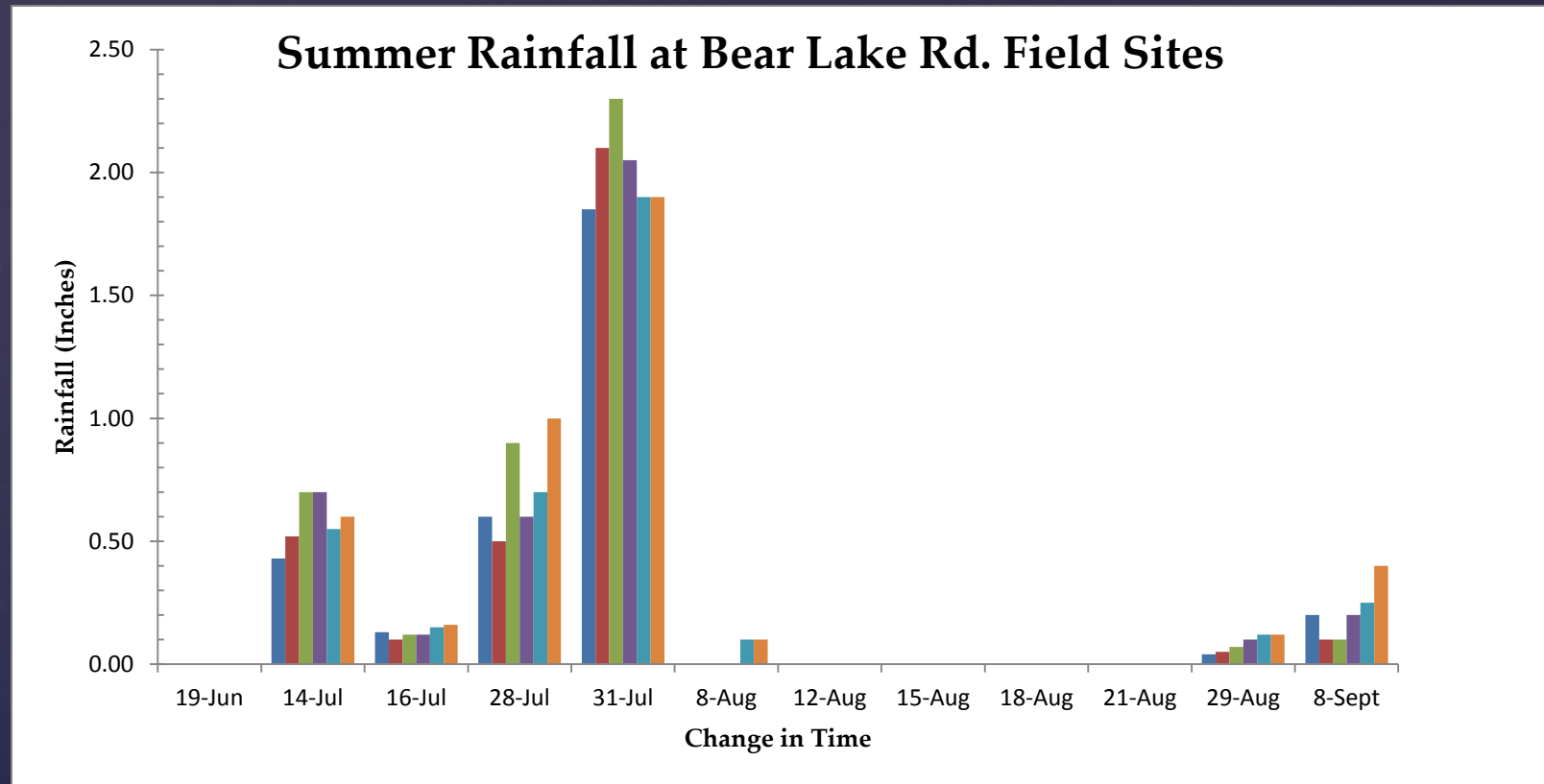


No difference in Native Cover among soil treatments.

Large variation among sites and treatments!!



Rainfall: Summer 2014



Some variation among sites in rainfall amounts.

Next Steps

1) Collect 2015 field data

- ⌘ soil moisture, temperature, nutrients, plant growth

2) Summarize results by functional groups

- ⌘ annual grasses, perennial grasses, annual forbs, perennial forbs

3) WP4 Soil dry-down study

- ⌘ How are amendments affecting water potential and water availability as soils dry out over time?

4) Write it up!!